Chapter 7

Recommendations

The following discussion presents EPA's recommendations for addressing sediment contamination throughout the United States and for improving the ability to conduct accurate sediment quality assessments. These recommendations relate to 7 activities or information needs:

1. Refine the assessment of the extent and severity of sediment contamination in the 88 targeted watersheds;
2. Continue to promote watershed management programs to address sediment quality;
3. Develop better coordination within the EPA on activities and research in the contaminated sediments area;
4. Continue to develop better monitoring and assessment tools;
5. Incorporate a weight-of-evidence approach and measures of chemical bioavailability into sediment monitoring programs;
6. Continue to increase the NSI's coverage, and;
7. Assess atmospheric deposition of sediment contaminants.

Recommendation 1: Refine the Assessment of the Extent and Severity of Sediment Contamination in the 88 Targeted Watersheds

To characterize the incidence and severity of sediment contamination in the United States, EPA has developed and performed a screening-level analysis of the information in the NSI from 1990 to 1999, the results of which are presented in Chapter 3. The results of this assessment should not be used as justification for requiring sediment remediation actions at potentially contaminated sites. This evaluation of the NSI data from 1990 to 1999 was performed as a means of screening and targeting. Additional site-specific data and information need to be collected to expand the NSI data evaluation into a comprehensive assessment of the incidence and severity of sediment contaminant problems within the various watersheds.

The main focus of this recommendation is to encourage both further investigation and assessment of contaminated sediment as well as initiation of pollution prevention and source control practices. States and tribes, in cooperation with EPA and other federal agencies, should proceed with further evaluation of the 88 watersheds containing areas of probable concern (APCs) for sediment contamination. Since this assessment utilizes data from 1990, it is likely in many cases, that much additional investigation and assessment has already been conducted (especially in well known areas of documented sediment contamination) and some areas have been remediated. If active watershed management programs are in place, further evaluations should be coordinated within the context of current or planned actions (e.g., TMDL development or sediment remediation). Future monitoring and assessment efforts should focus on the areas such as the 86 individual river reaches (or waterbody segments) located within the 88 watersheds containing APCs that had 10 or more stations categorized as Tier 1. The purpose of these efforts should be, as needed, to gather additional sediment chemistry data and related biological data (i.e., sediment toxicity, macrobenthic community analysis, etc.) and conduct further assessments of the data to determine human health and ecological risk, determine temporal and spatial trends, and identify potential sources of sediment contamination and whether the appropriate source controls are being applied. A helpful tool for delineating sediment contamination is a computerized sampling design program entitled the "Fully Integrated Environmental Location Decision Support" (FIELDS) system developed by the

EPA. This system is a set of software modules designed to simplify sophisticated site and contamination analysis. Each module is a self-contained unit that can be applied to a variety of scenarios. These modules offer power and efficiency in the characterization, analysis, and discrete sampling points can be interpolated into a surface area. Important uses of these interpolated surfaces include delineating hot spots, calculating average concentrations, estimating contamination mass and volumes, and developing post-remediation scenarios. More information on this system can be seen on the Internet at www.epa.gov/region5fields.

Additional monitoring and analysis of data from these watersheds containing APCs can also be used to track and document the effectiveness (or ineffectiveness) of sediment management actions that have been applied to address these areas over time. These trends will be useful in supplementing the results presented in Chapter 4 and could be reported in future reports to Congress. Comparisons to the 96 watersheds identified as APCs in the first *National Sediment Quality Survey* should not be made for potential trends in sediment contamination. Whereas the methodology used to designate APCs remained the same between the first report and this one, the methodology used to categorize sampling stations into the various Tiers has been updated from the first *National Sediment Quality Survey*. Also, since the first report focused on data collected basically in the 1980's and this report focuses on data collected in the 1990's in some cases sampling stations monitored for the first report to Congress were not evaluated for this report and vice versa (i.e., a watershed identified as having an APC in the first report may not have met the minimum data requirements to be evaluated as containing an APC in this report).

Available options for reducing or eliminating health and environmental risks from contaminated sediment are outlined in Chapter 5. Assuming further investigation reveals the need for management activities to address the risks posed from the contaminated sediments, the preferred means should resemble the nine remedy selection criteria outlined in the National Contingency Plan. These criteria include: the overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementabililty; cost; state (or support agency) acceptance; and community acceptance.

It is apparent from the plethora of data that has been compiled in the NSI database that many states and federal government monitoring programs already do a good job of gathering data at locations with known sediment contamination problems (including some of the 88 APCs), and additional monitoring at those locations may not be necessary. However, for other locations not previously targeted for focused monitoring, additional data might be required to adequately assess potential sediment contamination problems, especially in areas where significant human health exposures occur. In addition, in some cases it might be necessary to conduct baseline studies to determine where to focus monitoring activities. If during these studies it is determined that a biological impairment has occurred, a useful tool in discerning the cause or causes of that impairment is an EPA publication entitled the *Stressor Identification Guidance Document* (USEPA, 2000d). This document is intended to identify stressors causing biological impairments in aquatic ecosystems, and provides a structure for organizing the scientific evidence supporting the conclusions.

Recommendation 2: Continue to Promote Watershed Management Programs to Address Sediment Contamination

As was discussed in the first *National Sediment Quality Survey* and highlighted in this update, watershed management is a critical component of community-based environmental protection using watershed or hydrologic boundaries to define the problem area. Many public and private organizations are joining forces and creating multi-disciplinary and multi-jurisdictional partnerships to focus on water quality problems, community-by-community and watershed-by-watershed. These watershed approaches are likely to result in significant restoration, maintenance and protection of water resources throughout the United States. A watershed management framework requires a high level of inter-program coordination

to consider all factors contributing to water and sediment quality problems and to develop integrated, science-based, cost-effective solutions that involve all the stakeholders. It is within the watershed framework, therefore, that EPA recommends that federal, state, tribes and local government agencies pool their common resources and coordinate their efforts to address their common sediment contamination issues. These activities should support efforts such as selection of future monitoring sites, setting priorities for reissuance of NPDES permits, permit synchronization, TMDL development, and potential pollutant trading between sources. One example of addressing sediment contamination using a watershed management approach may be found in the Remedial Action Plan (RAP) process used in the Great Lakes areas of concern (AOC). In 1978 the Great Lakes Water Quality Agreement was established between the United States and Canada. The Agreement addresses forty-three AOCs recognized in the Great Lakes Basin. Having one or more specific impairments to fourteen beneficial uses recognized for the Great Lakes Basin identified these AOCs. This led to the initiation of the Remedial Action Plan. The RAP outlines the activities necessary for all stakeholders to complete when addressing a known contaminated area of concern. One RAP, as an example, is the Grand Calumet River/Indiana Harbor Ship Canal (GCR/IHSC) AOC. For the GCR/IHSC, all fourteen beneficial uses were determined to be impaired with contaminated sediments being associated with the majority of these impairments. As part of the RAP process for this AOC, a group of individuals was appointed to oversee the development of the Plan. This group is composed of representatives from industry, government (local, state, and federal), citizens groups, and academia to assist in the development and implementation of this Plan. One watershed approach used by this group was the development of a matrix that listed all actions occurring in the watershed that were associated (directly or indirectly) with the restoration of the impaired uses. This matrix is being used to assist in prioritization of activities as well as tracking success of actions taken to restore the beneficial uses. The RAP process may also be used to address areas of potential concern, as it sets forth the indicators used to detect environmental degradation and the benchmarks to measure progress.

This *National Sediment Quality Survey* provides an important and essential tool for targeting efforts to further investigate the 88 watersheds containing APCs. It is also useful in highlighting areas of concern where there are known data gaps for additional analysis. As more data becomes available and the NSI database expands, it will provide further information to help environmental managers better understand which of their watersheds have sediment contamination problems that pose the greatest risk to aquatic life and human health, and allow them to track progress as they address those problems. Also as more data is added to the NSI database, researchers will have more site-specific information to draw upon to conduct new analyses that could lead to new and better assessment techniques.

A vital component of watershed management is to educate and engage all stakeholders in government (federal, state, and local), industry, and the community. As part of EPA's *Contaminated Sediment Action Plan*, the EPA will continue to solicit stakeholder views on both science and policy issues affecting contaminated sediment management to promote better decision-making. In May 2001, the EPA sponsored a forum on managing contaminated sediments that brought together the Nation’s technical experts, stakeholders, and risk managers. EPA plans to hold additional meetings in the future to discuss Agency efforts and to address technical issues. Also as a part of the *Contaminated Sediment Action Plan*, the EPA will continue its efforts to improve community involvement during the investigation and cleanup of contaminated sites. In addition to providing communities with technical assistance opportunities, a workshop will be formed to identify methods to improve consideration of societal and cultural impacts of both baseline contamination and remedial alternatives at contaminated sites.

Recommendation 3: Develop Better Coordination Within the EPA on Activities and Research in the Contaminated Sediments Area

Many collaborative efforts regarding contaminated sediments currently exist within the EPA, the first being the Contaminated Sediment Management Committee (CSMC). This committee was recently

established to coordinate all the appropriate programs and their associated regulatory authorities involved in the management of contaminated sediments. The CSMC includes representation at the Office Director and Regional Division Director level from the Office of Solid Waste and Emergency Response (OSWER), the Office of Water (OW), the Office of Research and Development (ORD), the Office of Enforcement and Compliance Assurance (OECA), and many of the EPA Regions. This committee is developing the *Contaminated Sediment Action Plan* mentioned earlier. This Plan will outline the next steps for the Agency in the management of contaminated sediments. This multi-media, cross-program plan will describe the commitments from the EPA program offices to develop and apply sound science in managing contaminated sediments. Another collaborative effort to address contaminated sediments was the publication of the Agency's *Contaminated Sediment Management Strategy* (USEPA, 1998) in 1998. This document summarized the EPA's understanding at the time of the extent and severity of sediment contamination (as was described in the 1997 *National Sediment Quality Survey* and accompanying National Sediment Inventory database); described the cross-program policy framework in which the EPA intends to promote consideration and reduction of ecological and human health risks posed by sediment contamination; and identified actions that EPA believes are needed to bring about consideration and reduction of risks posed by contaminated sediments. The Contaminated Sediment Action Plan documents progress on a number of the actions outlined in this document. The Agency has also developed an EPA Science Inventory, which is a database of science activities for contaminated sediments. This database identifies current scientific activities and research efforts in the contaminated sediment area across the Agency. There has also been a precedent-setting team established by EPA's Region 5 in the Great Lakes. Since contaminated sediments were designated as a Region 5 Environmental Priority in 1995 because of the extent and severity of the problem across the Region, a Regional Contaminated Sediment Team was established. This team, formed with members representing a variety of regional programs and offices, coordinates all program/office efforts to address contaminated sediment sites and provide technical expertise to the Region, state agencies, and others.

A key component of future coordination within EPA in addressing sediment contamination is the contaminated sediment assessment pilots described earlier. As part of EPA's *Contaminated Sediment Action Plan*, the Office of Solid Waste and Emergency Response (OSWER), the Office of Water (OW), and the EPA's Regional Offices will initiate pilot projects to facilitate cross-program coordination on contaminated sediments. The pilot projects will bring a cross-Agency focus to identifying and assessing waters that are impaired by sediment contamination. The pilots will utilize the legal authorities and techniques available to satisfy the needs of both the Remedial Investigation/Feasibility Study (RI/FS) evaluations and Total Maximum Daily Load (TMDL) modeling. The ultimate goal of the pilots is to develop more watershed-based approaches to identifying, assessing, and preventing and remediating contaminated sediments. EPA will work with other Federal agencies, States, and interested stakeholders as these pilots are identified and implemented.

Recommendation 4: Continue to Develop Better Monitoring and Assessment Tools

The *National Sediment Quality Survey* reports (the initial report published in1997 and this current version) are the first attempts to analyze sediment chemistry and biological data from numerous databases in an effort to identify the national incidence and severity of sediment contamination. Because the data were not generated by one single monitoring program specifically designed to provide this national picture, numerous obstacles had to be overcome to analyze this data with as little bias and the most scientific validity as possible.

To ensure effective quality assurance and quality control (QA/QC) management, monitoring programs should adopt standard sample collection and storage procedures. To assist in this, the EPA has recently released a document entitled, *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses* (USEPA, 2001b). Interferences encountered as part of the

sediment matrix, particularly in samples from heavily contaminated areas, may limit the ability of available methods to detect or quantify some analytes. There is a need for cost effective methods, sensitive enough (i.e., low enough detection limits) to detect sediment contaminants and the chemical parameters that control bioavailability of contaminants such as PCBs, dioxins, PAHs, metals, and pesticides. QA/QC management will also be improved if databases include documentation of procedures used in the collection and chemical and biological analyses of sediment. The modernization of federal and other data repositories to accommodate the storage of this QA/QC documentation should help facilitate this process.

The development of this report has shown the need for additional "tools" to assist in the assessment of contaminated sediments. Although the EPA has recently released sediment toxicity test methods designed for evaluating sublethal effects (e.g., reduction in growth and reproduction) for some freshwater and marine/estuarine benthic species, protocols using new test species must be developed to provide sensitive tests (with both lethal and sublethal endpoints) representing a greater range of species and habitat types. Also, when applicable, standardized methods for measuring sublethal endpoints should be developed for current sediment toxicity tests that only look at lethality. Along with the development of additional sediment toxicity test methods is the need for field validation. Field validation determines the ecological significance of a reduction in growth or reproduction of organisms evaluated in the laboratory with sediments collected from the field. The EPA is currently evaluating the ecological significance of its recently released freshwater sediment toxicity test methods by comparing the results of sediment toxicity assays of spiked sediments to benthic colonization trays spiked with the same sediment concentrations and placed in the field. Results of this comparison should be available in 2002.

One concern about traditional sediment toxicity assays is that the toxicity might be altered because of manipulation of the sediment during its collection in the field and distribution into test vessels in the laboratory. One method that prevents this alteration is the use of *in situ* sediment toxicity test methods. This approach (which places the test organisms in the field instead of placing them in sediment brought back to the laboratory) has been used extensively in marine bioaccumulation studies using mussels. It is now being used effectively in sediment and storm water contamination studies using a host of biological species (Ireland et al., 1996). Further work needs to be done to standardize these methods to allow this approach to be utilized throughout the nation in monitoring programs.

Another tool that is needed for the assessment of contaminated sediments is the development of sediment toxicity identification evaluation (TIE) procedures. Since sediment contaminants most commonly occur in mixtures, there is a need for procedures to determine which contaminant is responsible for the observed toxicity. Currently, EPA's Office of Research and Development (ORD) is developing TIE methods capable of characterizing the toxicity of a sediment by identifying classes of toxic contaminants (e.g., metals, organics). More work is needed to improve upon this so that individual chemical contaminants can be identified. Additionally, work is needed to conduct field validation studies to support the TIE method development.

One approach used to evaluate the data in the NSI is the use of numeric sediment screening levels or sediment quality guidelines. These values are based upon concentrations of contaminants in sediment that are associated with potential adverse effects and have been proposed by a number of investigators around the world (Chapman, 1989; Long and Morgan, 1990; MacDonald et al., 1996; Ingersoll et al., 1996; USEPA, 1992; 1997; MacDonald et al., 2000; Field et al., 1999; 2001 [in press]). These values are needed by EPA, states and tribes, and other Federal agencies to: 1) help prioritize sites for further investigations; 2) help identify contaminants that are responsible for toxicity when it is observed by bioassays or other tools, and; 3) develop TMDLs and NPDES permit limits. EPA's Science Advisory Board (SAB) has found that the scientific basis for the Agency's draft sediment quality guidelines (ESGs) is sufficiently valid to be used in the regulatory process (SAB, 1992; 1996). However, the SAB and others have identified a number of needs to further support the regulatory use of the ESGs and other chemical-specific guidelines. Further field and laboratory studies would help evaluate the accuracy of

chemical-specific sediment quality guidelines in different sediment types. Almost all of the sediment screening levels and sediment quality guidelines to date have been developed for the protection of benthic organisms from direct toxicity and do not address potential food chain effects of bioaccumulative sediment pollutants (e.g., DDT and PCBs). Work needs to be conducted on developing sediment-screening levels for bioaccumulative contaminants that make their way up the food chain and that can cause adverse human health effects. Along with additional work on refining and developing sediment quality guidelines, a framework for the application of these values needs to be developed. In response to this need, a Society of Environmental Toxicology and Chemistry (SETAC) sponsored Pellston workshop was accepted and approved by the SETAC Board of Directors in September, 2001. This workshop is scheduled to take place in August of 2002 and has outlined several goals, one of which is to evaluate how various sediment management frameworks can incorporate multiple lines of chemical (i.e., sediment screening values) and biological evidence into assessments of sediment contamination.

The sediment quality evaluation tools used and outlined in this report should be used as the basis for future contaminated sediment assessment methods. As sediment quality data becomes more available and the state of the science for sediment assessment keeps evolving, better assessment methods will also evolve. As new and better sediment screening values and biological assessment techniques become available and proven to be reliable, EPA will incorporate them into future NSI data evaluations.

In the context of the budget process, EPA and other federal agencies should evaluate whether to request funding to support the development of tools to better characterize the sources, fate, and effects of sediment contaminants.

Recommendation 5: Incorporate a Weight-of-Evidence Approach and Measures of Chemical Bioavailability Into Sediment Monitoring Programs

As was pointed out in the initial *National Sediment Quality Survey*, and stated in Chapter 2, the ideal assessment methodology would be based on matched data sets of multiple types of sediment quality measures to take advantage of the strengths of each measurement type and to minimize their collective weaknesses. For example, sediment chemistry can indicate the presence of contaminants, but can't definitively indicate an adverse effect. On the other hand, toxicity tests or benthic community surveys can indicate an adverse effect, but cannot definitively implicate the causative contaminant. However, matched sediment chemistry data and sediment toxicity tests can provide a preponderance of evidence implicating a chemical (or chemicals) cause of an adverse biological effect. The use of sediment TIEs that were mentioned earlier is also extremely valuable tools in attributing cause to the observed effect. Studies have shown that overall, an integration of several methods using the weight of evidence is the most desirable approach for assessing the effects of contaminants associated with sediment (Long and Chapman, 1985; Long and Morgan, 1990; MacDonald et al., 1996; Ingersoll et al., 1996; 1997). In response to this, monitoring programs should be planned and implemented to support weight of evidence assessments when at all possible.

As the state of science is constantly evolving, EPA recommends that whenever possible future sediment monitoring programs collect tissue residue, biological effects (i.e., toxicity, histopathology), and biological community (e.g., benthic abundance and diversity) measurements along with sediment chemistry. These types of data are necessary to better assess actual adverse effects resulting from exposure to contaminated sediment. Matched sediment chemistry and tissue residue data should be collected where human exposures are a concern. In areas where aquatic life effects are a concern, monitoring programs should collect matched sediment chemistry, biological effects data, and biological community measurements. There is a need to evaluate matched sediment chemistry and toxicity data to determine the predictive ability of sediment-screening values to correctly classify sediment toxicity and minimize both Type I (falsely classifying a sample as toxic when it is not toxic) and Type II (falsely

classifying a sample as non-toxic when it is toxic) errors. Also, whenever possible, monitoring programs should use a randomized approach to select sampling stations. As was outlined in Chapter 6, the frequency of exceeding a sediment screening value in sampling stations known to be contaminated was 5 to 10 times greater than for randomly selected sampling stations.

The collection of measures of chemical bioavailability is critical to the success of weight-of-evidence assessments. These include acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) data and total organic carbon (TOC) data. AVS and SEM provide essential information necessary to assess the bioavailability of cationic metals in sediment. Where metals are expected to be a concern, sediment monitoring programs should collect AVS and SEM measurements. TOC provides information related to the bioavailability of nonionic organic contaminants. For the evaluation process used in this report, when TOC values were not reported, a default value was used for comparing measured sediment chemistry values to screening values. This approach resulted in the possible overestimation or underestimation of potential impacts. Therefore, EPA recommends that future monitoring programs also include TOC measurements wherever organic chemicals are a concern.

Recommendation 6: Continue to Increase the NSI's Coverage

The NSI database is currently limited in terms of the number of data sets it includes and the national coverage it provides. The data in the NSI used for the initial *National Sediment Quality Survey* published in 1997 consisted of approximately two million records for more than 21,000 monitoring stations across the country. The NSI database has been expanded and now includes more than 4.6 million analytical observations for approximately 50,000 stations throughout the United States. For this report, EPA used data from the NSI 1990 to 1999 and evaluated 19,470 stations that met the minimum data requirements to be evaluated. Over 50 percent of the monitoring stations evaluated for this report are located in five states (Washington, California, Illinois, Virginia, and Florida). In addition, only 8.8 percent of all river reaches in the contiguous United States contain one or more sampling stations that were evaluated for this report.

For this report, great strides have been made in adding to the NSI database. EPA is continuing to compile additional sediment chemistry data and related biological data for future reports. The focus of additional data additions will be to: 1) obtain a greater breadth of coverage across the United States, and 2) increase the number of waterbodies evaluated. This type of data will be extremely useful in future analyses to assess the changes in the extent and severity of sediment contamination over time.

The NSI database can be a powerful tool for water resource managers at the national, regional, state, watershed, and waterbody levels. It provides in a single location a wealth of information that could be very useful, especially with improved access and availability. All agencies should have access to the same data for decision making in regional, state-level, and watershed-level management. EPA released the NSI database in this report in early 2001 to give stakeholders a chance to use the data for their own purposes.

As part of the initial *National Sediment Quality Survey*, the EPA included the data used for that report in its comprehensive GIS/modeling system, Better Assessment Science Integrating Point and Nonpoint Sources (BASINS). EPA is currently working on getting the additional data in the NSI database into BASINS. In addition to this effort, EPA is also working with NOAA to incorporate the NSI database into Query Manager. Query Manager is a database program, developed by NOAA's Office of Response and Restoration, that can be used to access sediment chemistry (surface and subsurface), sediment toxicity, and tissue chemistry data from the relational database for individual watersheds. Users can select from a menu of queries that sort and analyze the data in a variety of ways to produce output tables. The selected data can be immediately displayed on maps using Mapping Application for Response, Planning, and Local Operational Tasks (MARPLOT), and/or the output tables from the queries can be saved in a variety of formats for use with other mapping software (e.g., ArcView) or other applications (e.g., spreadsheets, statistics packages, word processors). MARPLOT is a general-purpose desktop mapping program that was jointly developed by NOAA, the U.S. Coast Guard, and the Census Bureau. MARPLOT allows you

to create, view, and modify maps quickly and easily and to link objects on maps to data in other programs.

As was discussed in the first report to Congress, increased access to data and information in the NSI database has many applications. At the national level, the data and associated information can demonstrate the need and provide the driving force for increased pollution prevention efforts. It can also demonstrate the need for safer or biodegradable chemicals and determine the relative risk compared to other problems to assist in prioritization of activities. At the state and watershed level, better access to the information contained in the NSI can assist in educating and involving the public, setting goals and prioritizing activities and expenditures, and evaluating the adequacy and effectiveness of control actions, sediment remediation activities, and other management activities.

Recommendation 7: Assess Atmospheric Deposition of Sediment Contaminants

The relative contribution of contaminants to the sediment from air deposition has been virtually unknown on a national scale, but could be significant. Under section 112(m) of the CAA, EPA in cooperation with NOAA has been conducting a program to assess the contribution and effects of hazardous air pollutants on the Great Lakes, Lake Champlain, the Chesapeake Bay, and near-coastal waters. This program is referred to as the Great Waters Program. As part of this program, EPA has supported air deposition monitoring, fate and transport modeling, bioaccumulation assessments, and sediment contamination modeling. National scale deposition assessment modeling is currently underway. EPA has produced three reports to Congress documenting current knowledge about air deposition of hazardous air pollutants to the Great Waters, including source identification and effects. The third report, *Deposition of Air Pollutants to the Great Waters, Third Report to Congress* (USEPA, 2000e), outlines current programs underway to reduce air toxics, but also calls for additional deposition monitoring to more fully assess the contribution to water, sediment, and fish tissue contamination. Findings and conclusions from these reports will be incorporated in future iterations of the *National Sediment Quality Survey*.